# PATENT COOPERATION TREATY

# PCT



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

| Applicant's or agent's file reference<br>398/04198 | **FOR FURTHER ACTION** | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |
|---|---|---|
| International application No.<br>PCT/IL2005/000063 | International filing date *(day/month/year)*<br>19.01.2005 | Priority date *(day/month/year)*<br>08.04.2004 |
| International Patent Classification (IPC) or both national classification and IPC<br>INV. G08G1/16 G06T7/20 B60R21/01 G05D1/02 | | |
| Applicant<br>MOBILEYE TECHNOLOGIES LIMITED et al. | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

| Date of submission of the demand | Date of completion of this report |
|---|---|
| 08.02.2006 | 27.07.2006 |
| Name and mailing address of the international preliminary examining authority:<br>European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br>Fax: +49 89 2399 - 4465 | Authorized Officer<br>Seisdedos, M<br>Telephone No. +49 89 2399-7982 |

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL2005/000063

## I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

**Description, Pages**

1-14 as originally filed

**Claims, Numbers**

1-24 filed with telefax on 08.02.2006

**Drawings, Sheets**

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   *(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Yes: | Claims | 1-12,20-24 |
| | No: | Claims | 13-19 |
| Inventive step (IS) | Yes: | Claims | 1-12 |
| | No: | Claims | 20-24 |
| Industrial applicability (IA) | Yes: | Claims | 1-24 |
| | No: | Claims | |

2. Citations and explanations

   **see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following document:

   **D1:** US 2004/022416 A1 (LEMELSON JEROME H ET AL) 5 February 2004 (2004-02-05)

2. Clarity (Article 6 PCT)

   Since the clarity objection raised in sections 2.1 und 2.2 of the written opinion dated 7th of June of 2005 have not been overcome they still apply. Moreover, further clarity deficiencies have been found during the examination procedure. All of these will be discussed in the following lines:

2.1 Although **claims 1 and 20** have been drafted as separate independent method claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

2.2 Apparatus **claim 13** is claimed as comprising "at least one camera mounted in the vehicle.." and "a processor". It is not clear how a single apparatus can comprise the mentioned devices, which seem to be located in different parts of the vehicle, and where this apparatus is placed.

2.3 Last part of claim 13 claims a processor that "processes the data to determine TTC in accordance with any of claims 1-12". Claim 13 is an apparatus claim, whereas claims 1-12 are method claims and are accordingly defined in terms of method steps. Through the reference to claims 1-12 the apparatus claim is being defined by method steps and not in terms of apparatus features. For this reason claim 13 does not comply with Art.6 PCT.

3. Novelty (Art.33(2) PCT)

Since the presence of two independent method claims, claims 1 and 20, appears to be inappropriate (see section 2.1 of the present written opinion) and claim 1 seems to claim the special technical features of the invention as understood from the description, only claim 1 will be examined over Art. 33(1) PCT.

3.1 The document D1 is regarded as being the closest prior art to the subject-matter of **claim 1**, and shows (the references in parentheses applying to this document):

A method of estimating a time to collision TTC of a vehicle with an object comprising:
acquiring a plurality of images of the object (paragraph [0042]);
determining a TTC from the images that is responsive to a relative velocity and relative acceleration between vehicle and object (paragraphs [0049] and [0080]).

The subject-matter of claim 1 differs from this known method in that the time to collision (TTC) is determined "only from information derived from the images and the time intervals". The method described in D1 uses the information from standard images stored in the memory of the vehicle in order to identify the type of object and to determine the distance between the vehicle and the object (see paragraph [0049]). Since this information is not derived from the images it can be considered additional information. For this reason claim 1 appears to be new over D1 (Art. 33(2) PCT).

The problem to be solved by the present invention may be regarded as estimating the time to collision between a vehicle and an object with a low data processing complexity but still an accurate result.

None of the prior art documents cited on the International Search Report discuss or suggest using solely image data for determining the Time to Collision (TTC) between a vehicle and an object in its surroundings. Claim 1 therefore appears to fulfil the requirements of Art. 33(1) PCT.

3.2 Apparatus **claim 13** is claimed is broadly defined, since it basically claims an apparatus with a "camera mounted in the vehicle" and "a processor". The features which define the mentioned camera and processor can be executed by most types of cameras and processor since they are very general; acquiring images in the surroundings of a vehicle and processing data to calculate a specific parameter (TTC). For example, document D1 describes all the features of claim 13, see figure 2 and paragraphs [0042] and [0080].

Claim 13 therefore does not meet the requirements of Art. 33(2) PCT.

## CLAIMS

1. A method of estimating a time to collision (TTC) of a vehicle with an object comprising:

acquiring a plurality of images of the object at known time intervals between the times at which the images of the plurality of images are acquired; and

determining a TTC only from information derived from the images and the time intervals that is responsive to a relative velocity and relative acceleration between the vehicle and the object.

2. A method according to claim 1 and comprising determining the relative velocity or a function thereof from the images and using the relative velocity or function thereof to determine TTC.

3. A method according to claim 2 wherein determining the relative velocity or function thereof, comprises determining a change in scale of an image of at least a portion of the object between images of the pluralities of images and using the change in scale to determine the relative velocity or function thereof.

4. A method according to claim 2 or claim 3 and comprising determining the relative acceleration or a function thereof from the images and using the relative acceleration or function thereof to determine TTC.

5. A method according to claim 4 wherein determining the relative acceleration or function thereof comprises determining a time derivative of the relative velocity or the function of the relative velocity.

6. A method according to claim 3 wherein determining a change in scale comprises determining a ratio between a dimension of the object in a first one of the images and the same dimension of the object in a second one of the images.

7. A method according to claim 6 wherein determining a function of the velocity comprises determining a function $T_V = [1/(S-1)]\Delta T$ where S is the ratio and $\Delta T$ is a time lapse between two images of the images.

8. A method according to claim 7 wherein determining a function of the acceleration comprises determining a time derivative, $T'_V$, of $T_V$.

9. A method according to claim 8 wherein the TTC is determined responsive to a function of $T_V$ and $T'_V$.

10. A method according to claim 8 wherein TTC is determined responsive to the expression $TTC(t) = [T_V/C)][1-(1+2C)]^{1/2}$, where $C = T'_V+1$.

11. A method according to any of the preceding claims and comprising determining whether the vehicle and the object are on a course that leads to a collision at the TTC.

12. A method according to claim 11 wherein determining whether the vehicle and object are on a collision course comprises:

determining motion of at least two features of the object relative to the vehicle from the images; and

determining from the relative motions whether at TTC the first and second features straddle at least a part of the vehicle.

13. Apparatus for determining a time to collision (TTC) of a vehicle with an object comprising:

at least one camera mounted in the vehicle and adapted for acquiring images of objects in the environment of the vehicle; and

a processor that receives image data from the camera and processes the data to determine a TTC in accordance with any of claims 1-12.

14. Apparatus according to claim 13 wherein the at least one camera comprises a single camera.

15. Apparatus according to claim 13 or claim 14 and comprising alarm apparatus for alerting a driver of the vehicle to a possible collision with the object responsive to the TTC.

16. Apparatus according to any of claims 13-14 and comprising alarm apparatus for alerting persons outside of the vehicle to a possible collision of the vehicle with the object responsive to the TTC.

17. Apparatus according to any of claims 13-16 wherein the at least one camera images an environment in front of the vehicle.

18. Apparatus according to any of claims 13-17 wherein the at least one camera images an environment in back of the vehicle.

19. Apparatus according to any of claims 13-17 wherein the at least one camera images an environment to a side of the vehicle.

20. A method of determining whether a first object and a second object are on a collision course comprising:

acquiring an image of the second object from a position of the first object at each of a plurality of known times;

determining motion of at least two features of the first object relative to the second object from the images;

determining an estimate of a possible time to collision (TTC) of the first and second objects; and

determining from the relative motions whether at the TTC, the first and second features straddle at least a part of the vehicle and if so that the objects are on a collision course.

21. A method according to claim 20 wherein determining motion of the at least two features comprises determining lateral motion of the features relative to the first object.

22. A method according to claim 21 wherein determining whether the features straddle the first object at the TTC comprises extrapolating lateral locations of the features at TTC from their motion at times at which the images are acquired.

23. A method according to any of claims 20-22 wherein determining TTC comprises determining TTC from the images.

24. A method according to claim 23 and determining TTC only from the images and time intervals between times at which the images are acquired.